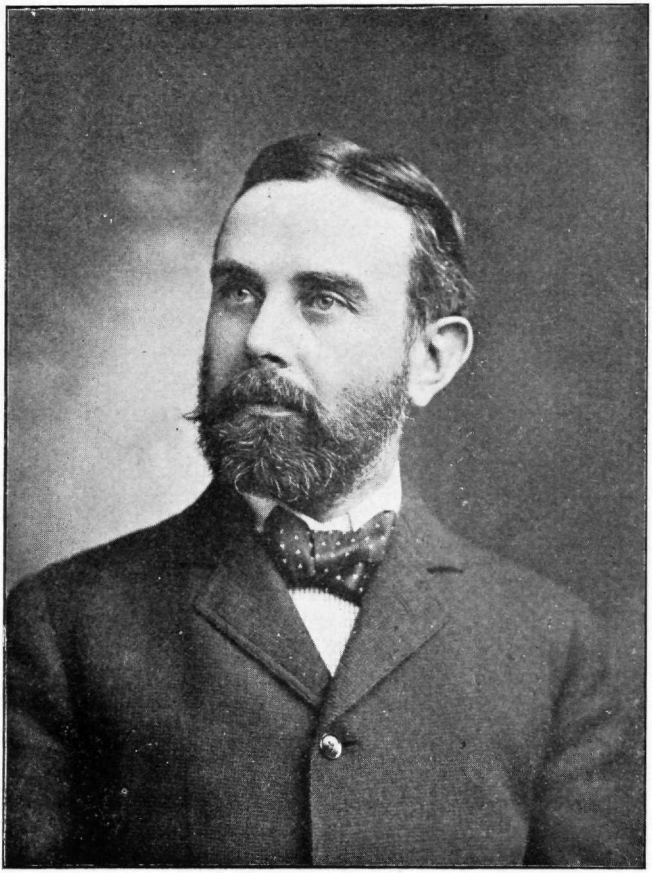

W. G. WILKINS

SURFACE PLANTS OF BITUMINOUS COLLIERIES.

W. G. WILKINS, C. E.

The competition in the bituminous coal trade, like that in most all lines of manufacturing, has become so keen that only those operators whose mines are so equipped and managed as to mine, screen and load their product at a minimum cost, are able to make anything like a fair profit on the capital invested.

The writer believes that the time is not far distant when the coal operator, like the manufacturer, who does not have his plant, both underground and surface, so designed and equipped that he can effect every saving possible, will be forced out of business, or be content to supply a small and purely local trade. The writer also believes that a still further reduction in the cost of coal production will be brought about by changes which are already being effected, by a consolidation of various operators and corporations now operating the mines, by which such charges as commissions, office expenses, superintendence, etc., may be reduced to a minimum. On this point F. Schellenberg, President of the Central Mining Institute of Western Pennsylvania, said in his annual address: "The first solution of the problem being in the consolidation of capital (and through the influence of the transportation companies it may be accomplished) for such control as may insure the regular systematic exhaustion of the coal fields, with adequate improvements for the security, welfare and health of the workman and keeping him regularly employed to the advantage of getting the coal without waste inside and outside."

Many mines are now worked on modern principles whereby the maximum amount of coal is taken out and have their underground workings equipped with mechanical coal cutters, mechanical haulage plants, and have economical and up-to-date pumping and ventilating plants, so that the coal is taken out at as small cost as possible. There is, however, still further saving by having the surface plant so designed and laid out as to screen and load the coal into the railroad cars as quickly and cheaply as practicable, consistent with the quality of coal the market demands.

It is the design of this paper to call your attention to some of the principles and appliances that should be considered in the design, laying out, and construction of the surface plants of bituminous collieries, in order to save labor and expense, and therefore reduce the surface cost of the mine output.

The design and appliances of the surface plant will depend somewhat upon whether the mine be opened by a shaft, slope or drift. An ideal shaft mine would be one in which the shaft was in the middle of the tract of coal to be mined, and in which the dip of the coal was towards the bottom of the shaft, so that the drainage, as well as the load haul, would all be in that direction, which would of course mean the minimum cost for pumping and hauling. In addition the topography at the surface around the shaft should be such that the surface plant could be so laid out as to give the smallest cost both for construction and operation. These are conditions that are quite rarely met with in practice, as the location of the railroad over which the coal is to be shipped and the topography of the surface will fix the location of the surface plant, and with these conditions the engineer must do the best he can with his underground work, making it subordinate to the surface layout.

As to the relative advantages of shaft, drift or slope mines, the question very seldom presents itself for solution, for as said before, the location of the railroad generally fixes the location of the surface plant, and if the coal is many feet below the surface, a shaft of necessity must be sunk; if the coal is at about the height of the tipple floor, a drift is the result, and if the coal is only a few feet below the surface, a slope will probably be selected as the cheapest method of bringing the coal to the tipple.

The firm of which the writer is a member, were the engineers of the surface plant of the Vulcan Coal Company's Treveskyn Mine. The situation was such that the coal could be reached by a shallow shaft, or by a slope. After consultation with the superintendent and the company's mining engineer, Mr. Frank Greene, it was decided that the slope was preferable, not only on the grounds of first cost, but also economy in the operation. The grade in which the slope was driven was 25 feet per 100, and the grade of the main haulage way of the mine descends towards the foot of the slope at about one foot per hundred, in favor of the loads. Instead of the wire rope haulage, usual in such cases, it was decided to use a chain haul. There are two endless chains, one in the load track and the other in the empty, the return in each being under the ties. Each chain is formed of four flat steel links, the up chain being considerably the heavier. Each chain is

provided with dogs which engage a steel bar under the cars. When the loaded cars reach the knuckle at the top of the grade they are automatically released from the dogs and run by gravity to the tipple, while the empty cars run by gravity from the kick back to the head of the empty chain, where they are caught by the dogs and lowered down the slope, at the bottom of which they are automatically released, and run by gravity down a 10% grade about six hundred feet. The chains are driven by a 75 H. P. engine situated under the tipple approach. The chains run at a speed of 60 feet per minute and have a capacity of four cars a minute. So far as the haulage plant is concerned, it takes only one man to attend to it, who puts the loaded cars on at the bottom, the engine being under control of one of the men at the dump. The entire apparatus has proven very satisfactory, and it is certain that the cars are taken from the mine at a less cost than could be done with a shaft and hoisting engine.

Having settled upon the approximate location of the plant, the first thing to be done is to have an accurate topographical survey and map made, by the aid of which the final location of the itpple, railroad tracks, and buildings may be determined in such a manner that the amount of grading required and the amount of foundation may be kept at a minimum. The cost of such a survey may be more than offset by the saving that may be effected in these two items alone. In order to have a plant that is to be economically operated and built, the exact location of all the various parts should be considered in their relations to each other, and be determined upon in advance of their construction. They should be so arranged and designed that if extensions or additions are to be made at any time with a view to increasing the output, it may be done with the same ideas of economy in operation in view, and in such a way as to preserve as far as possible the symmetry of the plant, and avoid the appearance of having been thrown together, as if there had been no well considered plan as to what the final plant was to be. Too many plants have been built in this way, seemingly with the idea of saving the cost of the services of a competent engineer.

Now as to some of the economies that may be had in a well designed plant. One of the first is a proper alignment of the railroad tracks and their grades. The number and length of these tracks will depend upon the grades and amount of coal to be shipped. If only run of mine coal is to be loaded, a single track under the tipple may be all that is necessary. If lump, nut, slack and run of mine are all to be shipped, the number of tracks will be four at least, and unless the tracks are connected

at both ends with the main railroad track, so that the empty cars can be dropped in at the upper end and hauled out at the lower end, there should be a track outside of the tipple tracks, so that the empty cars can be placed at the upper end without interfering with cars that are being loaded on the tipple tracks. It will be found convenient to have standing room on the tracks above the tipple, for a day's run of empty cars, and room enough to hold them below the tipple after they are loaded, especially if the mine is on a branch railroad, and dependence has to be placed upon the railroad company to do the shifting. The tracks should have sufficient down grade towards the tipple so that empty cars can be dropped by gravity by simply letting off the brakes. The grade should, however, not be too great, as with heavy grades cars are apt to get away on slippery tracks and cause damage. Grades of about 1.25% to 1.5-10% are sufficient above the tipple and from 9-10 to 1.2 below the tipple for the loads, especially if they are kept in good line and surface. By these precautions, it will not be necessary to use pinch bars to start either the empty or loaded cars, and thus time will be saved in getting the cars to and from the tipple, and the capacity of the plant will be increased, or the time used in loading the day's run will be lessened.

A further saving of time and labor can also be effected by the use of automatic crossover tipple dumps, such as the Mitchell, Willson or Phillips. By the use of these no time is lost by having to pull the pit car back from the dump after its load is discharged, which is the case with the old style of dumps, before the next loaded car is brought to the dump. Their use not only saves time, but is also the means of dispensing with at least one man on the tipple. As is well known to you all, the loaded cars approaching the dump releases the dogs holding the empty car that has just been dumped, and allows it to pass over the dump to the kick back from which it runs by gravity to the return empty track. The Nelsonville Foundry and Machine Company have also a cross-over dump, which is tipped by means of a steam cylinder or ram, which raises and lowers the rear end of the dump.

At shaft mines the capacity of the mine may also be increased and a saving of labor effected by the use of automatic dumping cages, which allow the pit cars to be dumped without leaving the cages. At one of the mines of the Kansas & Texas Coal Company, of St. Louis, the output of the mine was limited by the number of cars that could be hoisted up the shaft. The mine being a three vein mine, the cars were of necessity low, and the capacity of the shaft correspondingly small.

Mr. Bond, the Chief Engineer, determined that the capa-

city of the mine could be increased if he could only bring more coal up the shaft. His first idea was to use the double deck cage so as to hoist two cars at the top, but after consideration gave up this idea and instead substituted a self-dumping hopper, suspended below the cage already used. The floor of the cage was divided in the middle and hinged at the sides, forming two doors which could be raised and fastened vertically at the sides. The coal was dumped into the hopper at the bottom so that the mine cars never came out of the mine except for repairs. The hopper was made large enough to hold two cars of coal, so that the capacity of the shaft was thus doubled, and not only this, but the labor of three men was dispensed with at the top. With a soft tender coal there might be an objection raised to this plan as being too hard on the coal consequent on its being dumped twice, once at the bottom and again at the top. This, however, would not be an objection at a coke works, where the more the coal is broken up, the better the coke.

Another device for use at a shaft which, while it does not reduce the number of men required at the top, increases the capacity of the mine, by reason of the decreased time required in caging the mine cars, is the "Ramsey Caging Apparatus." This device is the invention of Robert Ramsey, General Manager of the Standard Coke Works, and as with it the coal is only dumped once, the objection on that account to Mr. Bond's hopper can not be urged against this. The apparatus consists essentially in two steam rams placed back of the shaft and two transfer tracks running on a track across the tipple in the rear of the head frame, which are operated by a steam cylinder. Its operation is as follows: After a car has been dumped it runs back by gravity past one side of the head frame onto one of the transfer tracks, which is then moved by means of the steam cylinder to the rear of the compartment where the next loaded car is coming up. When the cage with the loaded car is at the landing the empty car is pushed by means of one of the steam rams against the loaded car, which is then taken off the cage and the empty car left on the cage ready to descend, so that the loaded car is shoved from the cage and the empty one pushed on all at one operation, thus saving considerable time in the caging. When one transfer track is back of the head frame with its empty car, the other track is in position to receive the next empty car as it comes from the dump.

As to the capacity of the apparatus, there has been handled at the Standard Works 3,021 tons of coal in 8½ hours, or for 275 days in 1889 an average of 2,143 tons. While this apparatus has thus far principally been used at coke works mines, it

would seem that its combination with automatic crossover dumps, at a tipple with two dumps would form an admirable combination at a mine where the shipments would run from two to three thousand tons per day.

At the First Pool Mines near Pittsburg, Mr. Selwyn Taylor, M. E., has devised a novel method for taking the empty cars from the dump to the rear of the head frame, where they are caged. The operation is accomplished partly by gravity and partly by means of a dummy devising car, to which motion is given by means of a wire rope from the shieve shafts. There are switches and "kick backs" at both ends of the tipple, the ones at the front to send the cars to the dummy and the one at the rear to send them down to the back of the head frame preparatory to their being caged. The device accomplishes the purpose for which it was intended in an economical manner, as the power required is furnished by the main hoisting engine, instead of by rams as in the Ramsey Apparatus.

Another source of saving is in having the boiler house so located that the coal for the boilers may be taken in pit cars and dumped either in the boiler house directly in front of the boilers, or into a bin outside of the house from which the coal can run by gravity to the front of the boilers, thus saving handling of the coal used in making steam. The boiler house should be located, if possible, on a lower level than the engine house, so that the main steam pipe will drain towards the boilers, which will result in having dryer steam with a consequent saving of wear and tear on the engines. The use of a steam separator and feed water heater is also advisable, the first to give dry steam and the latter to save fuel.

Some of the methods recommended above for effecting a saving may seem trifling, but it should be remembered that pennies make dollars, and a saving of here a little and there a little every day, in the course of a year's run means the transfer of the balance of the profit and loss account from the wrong to the right side of the ledger.

A few words as to the character of the structures composing the surface plant may not be out of place. Most of the mining laws of the various states provide that all structures near the shaft or pit mouth must be covered with fire proof material. The writer believes that at plants which will in the future be very largely built, plants having a capacity of two thousand tons a day and upwards, that it is economy in the end to build the tipple or head frame of steel, and the various buildings of the same material, or better still of brick with steel roof trusses. The danger of fire is lessened, thus reducing the cost of the insurance, and it also has a good effect on the em-

ployes of the surface plant. The writer believes that the machinery will receive better care and attention if it is placed in a well built and commodious building, than if it is covered with a building that some farmers would not have a cow in.

The number, kind and arrangement of the screens and chutes in the tipple will vary according to whether run of mine coal only, or various sizes are shipped, and whether the miner is paid for run of mine or lump coal weight. The character and pitch of the screens will depend upon the nature of the coal, whether hard or soft and friable, and whether wet or dry. The arrangement will also vary in accordance with whether the slack can be loaded direct into railroad cars as the coal is screened and shipped immediately, or whether the slack must be stored while waiting shipment or sale. The number and arrangement of screens and chutes will also depend upon the output of the mine, as the amount of coal that can be properly screened over one set of screens will vary with wet and dry coal. The arrangement will also vary when box cars as well as gondolas are to be loaded.

When it is considered that there are flat bar screens, diamond bar screens, and perforated plate screens, that some or all may be stationary, that some or all may be shaking screens that some may be revolving screens, and that the coal as it comes from the mine may contain so much slate that picking tables may be necessary, it will be seen that the design for a triple equipment to produce the best results with the coal that is to be screened is not a simple proposition. When all the factors as noted above are taken into account, the problem becomes more complicated than would at first sight appear.

At some mines in Pennsylvania, the miner is paid for run of mine coal, and the coal is not screened at all before shipment. Where these are the conditions the tipple equipment is a comparatively simple matter, as it consists only of the tipple dumps and chutes for discharging the coal into railroad cars. With a plant of this kind three thousand tons of coal have been loaded in ten hours, over two dumps. Where, however, the coal is screened before shipping, the tipple equipment is more complicated as shown above.

As the majority of mines are situated at some distance from towns where there are machine shops, and as there are always more or less repairs to machinery and pit cars required, it is almost a necessity to provide not only a blacksmith shop, but also machine and carpenter shops. The size of these shops and their equipment will depend upon the extent of the plant and the capacity of the mine. The carpenter shop should be so situated that the pit cars can be run on tracks from the

pit mouth directly into the shop, and the blacksmith shop should be close to it, so that any smith work connected with the cars can be done quickly and without loss of time going from one shop to the other. The machine shop should also have a track running from the pit mouth into it, and if electric or compressed air locomtives are used, there should be a locomotive pit in the machine shop, to allow access to the underside of the locomotive without being compelled to jack it up off the tracks. The tools necessary for machine work are about a 24"x10' engine lathe, a drill press, grindstone, and one or more work benches.

If compressed air is used in the mine, the blacksmith's forges can be blown with this medium, and the ordinary blacksmith's bellows can be dispensed with. The blacksmith shop should also be furnished with racks for the storage of the various sizes of bars that are to be kept in stock.

About as convenient an arrangement as can be had for the shops is to have them all in one building, which can be divided into three rooms, one for the carpenter, one for the blacksmith and the third for the machine shop. By this plan all the operations of repairs requiring the three kinds of work are kept close together, and no time is lost in running from one shop to another.

A source of frequent loss at coal mines, although not a loss by reason of too great operating expenses, is the loss of stock and hay from the burning of the barns and stables. The barns as usually built consist of two stories, the mules and horses being kept on the ground floor and the hay in the loft above. Owing to the large losses occasioned by the burning of such barns, it is becoming the custom in the Connellsville region to build two buildings of one story each at some distance apart, in one of which the mules and horses are kept and the other being for the storage of hay only. The stable having two lines of stalls with a passage way between them through which runs a track leading from the hay barn, on which is run a truck for taking the hay from the barn to the stable. By this means the danger of loss by fire is lessened, as if one building catches fire the other is safe, as in the region spoken of the two buildings are generally iron clad, or brick with slate roofs. The Hecla Coke Co. and the Southwest Connellsville Coke Co. have both adopted this plan.

One important feature of the surface plant is the ventilating fan, where the ventilation is provided by this means. The writer has quite recently been present at some tests, and has the results of other tests that have been made by the "Capel Fan." He has had one installed under his own superivsion and he believes it to be only justice to Mr. Clifford, the owner of

the patents for the United States, to say that he believes it to be the most efficient fan that has yet been invented for ventilating coal mines. The fan last referred to is a single inlet fan 13½ and 5½ feet wide, and gave over one hundred thousand feet on a water guage of one inch and over 200,000 feet on a four-inch guage, the fan running 228 revolutions.

With reference to the type of boilers best to be adopted to mine work, the author believes there is no better type, and none which will give more satisfactory service year in and out when first cost is taken into account, than the ordinary return tubular boilers having four-inch tubes. It has the advantage over the plain cylinder or two-flue type, in that it requires smaller shells, for the same power, thus reducing the size of the boiler house and also the boiler settings.

While some of the author's opinions may not be concurred in by others, they are opinions he has formed from the results of his experience as an engineer during the past ten years.

MR. WILKINS: Another matter is the methods very commonly adopted in installing the power plants for machine mining. The custom is to go to the machine manufacturer and tell him you would like him to figure on a plant for so many tons or to run so many machines. Every bidder cuts down the size of his power plant to the lowest notch to get the contract. I know three cases—one operator was in the office yesterday complaining of this thing. He said the result was that he must just double his generator plant. I asked how the plant was contracted for, whether there was special provision as to size of generators and engines. He said no; he just told them he wanted to run six machines and locomotive, and three parties gave prices and he gave it to the lowest man. I asked what size he got. He said, 150 horse power. I asked if they told him what they calculated to each machine. He said yes, 15 horse power. Fifteen horse power is even less than the average power required for a machine, and the result is he has got to put in another generator for his machines. He will not require that contractor to bid on the machine, either.

If the operator would employ a competent engineer to get up specifications as to size of plant, I am satisfied if he knew his business he would not desire a power plant too small, but probably a little in excess of his actual needs. The result

would be that the manufacturer who got the contract would get more money for the plant, which is a good thing for him, and the operator himself would not be damning the contractor in the future because he did not put in a large enough plant. I think it would be better to have specifications so that all will bid on exactly the same thing. (Applause.)

PRESIDENT RAY: We have all heard Mr. Wilkins' paper and have been highly entertained thereby; and I think we will heartily agree with what he says. I think the tendency is growing in favor of specifications made by engineers for works of any importance. Custom is being moulded in that direction. It saves money for the people investing their money, and the manufacturers prefer this method of actual specifications to bid on.

Is there any discussion? As I said before, we will have to be brief if we desire to finish the program this afternoon, as we have a long list of papers yet.

SECRETARY HASELTINE: Mr. Morrison and Mr. Wilkins have come a long way to entertain us and it seems the members of the Institute might profit by a discussion of the papers read by them.

I have been especially impressed with Mr. Wilkins' paper and the minuteness with which he has studied the subject. His mode of moving the coal is entirely new to me; at least I never thought of using the two chains working in opposite directions. I think if we could only induce the people to prepare more such papers it would be of great benefit to the members of the Institute and to people connected with the industry throughout the nation. I wish every mine superintendent, mine boss and engineer in Ohio could have heard Mr. Wilkins' paper. He would certainly have gone home with more information than he possessed when he came here. I do not think we can be too grateful to these gentlemen for coming here and presenting the papers which we have heard this afternoon.

MR. WILKINS: There is one little detail connected with that hoisting plant which may be interesting. That is, the method of taking care of the empty car as it comes to the top

of the down grade. No two cars run with exactly the same speed. At first the trouble was with the grade. Sometimes the car running too fast would come down against the dog, and the result would be a bent dog or a bent bar on the car. So we made up our minds we had better make a grade from the kick-back enough to take through the top and provide a method of stopping the cars just before they got there and let the next dog catch it. We simply took two pieces of angle iron, equal in weight, and kept it pressed up against the rails; and by experimenting with the weights got enough weights to just stop the car; then a short auxilliary chain protects the car and pulls through that switch and delivers through to the empty chain; and it works satisfactory. They all go through and it is all done without any trouble, and one man can attend to the whole thing.

SECRETARY HASELTINE: I did not quite catch that remark.

MR. WILKINS: This device for catching the car at the top of the tipple, after it comes back from the kick-back, the empty car. With a free running car it will run down and either break the dog or the bar on the car. We put another sprocket back here (indicating) with auxilliary chain, and between the track at that point (indicating) put these rails here, and by weights underneath kept those angle irons pressed against the rail and formed a sort of break and just stopped it —those dogs are pivoted, and turn round and go over. The next dog catches it as this dog lets go. One hundred and fifty feet is about the limit I would want to work that on.

MR. THOMAS: What grade on that slope?

MR. WILKINS: Twenty-five per cent.

PRESIDENT RAY: There is a plant in the Hocking Valley, which has been built for six or eight years, where the tipple has a device on a small scale like that, for handling the coal around the tipple.

MR. WILKINS: I had heard of that and that gave me the idea and made me enlarge it.

MR. THOMAS: The tipple at Number Two is the same plan as the Ramsey, running the car back, except in the Ram-

sey the car comes at the side. Number Two has a special ridge for the cars to run up and down again.

What holds the car on the cadge where the Ramsey tipple is used?

MR. WILKINS: Dogs on the cage; and the latest patents Mr. Ramsey has on that is that neither one of those steam cylinders can be operated unless the cage is up at the landing.

On motion of Mr. Coxe, a vote of thanks was extended to Mr. Wilkins for his paper.

PRESIDENT RAY: The next paper is one by Mr. Palmros of the Jeffrey Manufacturing Company, "The Cost of Power in Electric Coal Mining."